

Amendment and Response

Applicant: Winthrop D. Childers et al.

Serial No.: 10/808,897

Filed: March 25, 2004

Docket No.: 200314128-1 (H301.367.101)

Title: CELL TRANSPORTER FOR A BIODEVICE

IN THE CLAIMS

Please cancel claims 25-30.

Please add new claims 31-32.

Please amend claims 1-19 and 21-23 as follows:

1. (Currently Amended) A biodevice comprising:

an array of operative stations with each respective operative station configured for performing an operation on cells; and

A transporter of a biodevice configured for transporting cells during a transport time period, the transporter in fluid communication with at least one of the respective operative stations and independent of and separate from the at least one respective operative station, the transporter comprising:

a motion-inducing apparatus configured to induce transportation of the cells along a transport path of the biodevice between the respective other operative portions of the biodevice, the apparatus comprising an electrode arrangement configured to apply a non-uniform electric field to the cells; and

a transport control unit coupled to the motion-inducing apparatus to control transportation of the cells and providing control signals to the motion-inducing apparatus during the transport time period to:

induce a primary motion of the cells to drive transportation of the cells along the transport path; and

induce a secondary motion of the cells to discourage aggregation of the cells during transportation of the cells on the transport path without performing, via the at least one respective operative station, an operation on the cells.

2. (Currently Amended) The transporter biodevice of claim 1 wherein the transport control unit of the transporter is configured to operate the motion-inducing apparatus such that the primary and secondary motion occurs at least one of simultaneously during the transport time period and alternately during the transport time period.

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3. (Currently Amended) The biodevice transporter of claim 1 wherein the motion-inducing apparatus of the transporter includes a first apparatus that induces the primary motion and a second apparatus that induces the secondary motion.
4. (Currently Amended) The biodevice transporter of claim 3 wherein the first apparatus and the second apparatus are vertically disposed with respect to one another.
5. (Currently Amended) The biodevice transporter of claim 4 wherein the second apparatus is disposed on a first substrate and the first apparatus is disposed on a second substrate, with the first and second substrate being spaced from one another so that the transport path extends generally parallel between the first apparatus and the second apparatus.
6. (Currently Amended) The biodevice transporter of claim 1 wherein the primary motion is induced by a fluid pressure flow drop along the transport path.
7. (Currently Amended) The biodevice transporter of claim 5 wherein the first apparatus comprises a first portion of the electrode arrangement, which is configured to impart a traveling wave in the non-uniform electric field.
8. (Currently Amended) The biodevice transporter of claim 7 wherein the second apparatus comprises a second portion of the electrode arrangement and comprises a plurality of elongate electrode elements extending along a length of the transport path and arranged generally parallel to the direction of primary motion along the transport path, the electrode elements spaced apart from each other and extending generally parallel to a longitudinal axis of the transport path, wherein the elongate electrode elements are configured to apply a non-traveling wave, spatially varying electric field between the electrode elements to define a plurality of generally parallel and independent channels in the transport path between the elongate electrode elements to substantially prevent cell aggregation along the transport path via maintaining the cells in the different respective independent channels.

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9. (Currently Amended) A transporter of a biodevice for transporting cells during a transport time period, the transporter comprising:

a motion-inducing apparatus configured to induce transportation of the cells along a transport path of the biodevice between other operative portions of the biodevice, the apparatus comprising an electrode arrangement configured to apply a non-uniform electric field to the cells and the motion-inducing apparatus including a first apparatus and a second apparatus with the first apparatus being vertically disposed relative to the second apparatus; and

a transport control unit coupled to the motion-inducing apparatus to control transportation of the cells and providing control signals to the motion-inducing apparatus during the transport time period to:

induce a primary motion of the cells, via the first apparatus, to drive transportation of the cells along the transport path; and

induce a secondary motion of the cells, via the second apparatus, to discourage aggregation of the cells during transportation of the cells. The transporter of claim 4

wherein the first apparatus is overlaid onto the second apparatus in a single substrate, with both the first apparatus and the second apparatus disposed underneath the transport path, and wherein the second apparatus comprises a piezoelectric device configured to apply a vibratory force to the cells for preventing aggregation of the cells during the transport time period.

10. (Currently Amended) The biodevice transporter of claim 3 wherein the second apparatus is a plurality of electrode elements disposed on at least one of a top substrate and a bottom substrate, with the plurality of electrode elements including a first outer set and a second outer set of electrode elements, with the first outer set disposed on a first side of the transport path and the second outer set disposed on a second side of the transport path, and wherein the electrode elements within each of the respective first outer sets and second outer sets are longitudinally spaced from each other along the transport path.

11. (Currently Amended) The biodevice transporter of claim 10 wherein the first and second outer sets of electrode elements are disposed on the bottom substrate, and the

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electrode arrangement further comprises a central electrode array of electrode elements that is disposed underneath the transport path centrally between the first outer set and the second outer set of electrode elements.

12. (Currently Amended) The biodevice transporter of claim 11 wherein each electrode element of the central electrode array corresponds to, and is aligned generally parallel to, one electrode element of each of first outer set and second outer set of electrode elements, which are located laterally relative to each electrode element of the central electrode array on opposite sides of the corresponding electrode element of the central electrode array.

13. (Currently Amended) The biodevice transporter of claim 12 wherein the transport control unit operates the first and second outer sets of electrode elements in a mode that applies a traveling wave in the non-uniform electric field in cooperation with the central electrode array.

14. (Currently Amended) The biodevice transporter of claim 12 wherein the transport control unit operates the first and second outer sets of electrode elements in a mode that applies the non-uniform electric field to deliver the secondary motion as an electro-rotational force on the cells.

15. (Currently Amended) The biodevice transporter of claim 12 wherein the transport control unit operates the first and second outer sets of electrode elements in a mode that applies the non-uniform electric field within the transport path to the cells to move the cells toward a center of the transport path.

16. (Currently Amended) The biodevice transporter of claim 12 wherein the transport control unit of the transporter operates the first and second outer sets of electrode elements in at least two of three modes including:

a first mode that applies a first traveling wave in the non-uniform electric field in cooperation with the central electrode array;

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a second mode that applies a second non-uniform electric field to deliver the secondary motion as an electrorotational force on the cells; and

a third mode that applies a third non-uniform electric field within the transport path to the cells to move the cells toward a center of the transport path.

17. (Currently Amended) The biodevice transporter of claim 12 wherein all the outer electrode elements and the central electrode array operate as the first apparatus in a first time period, and wherein in a second time period, only the central electrode array operates as the first apparatus.

18. (Currently Amended) The biodevice transporter of claim 1 wherein the electrode arrangement of the motion-inducing apparatus is configured to apply the non-uniform electric field as a temporally varying non-uniform electric field.

19. (Currently Amended) An apparatus for moving cells on an electronic biodevice between operative stations on the biodevice during a transport time period, the apparatus comprising:

means for imparting a primary motion of the cells on the biodevice along a cell transport path to transport the cells between the operative stations on the biodevice, and a secondary motion of the cells to substantially prevent aggregation of the cells during the cell transport on the cell transport path, wherein the means for imparting is independent of and separate from the operative stations that are in fluid communication with the cell transport path; and

means for controlling the means for imparting, via control signals, to selectively activate the primary motion to move the cells along the cell transport path and to selectively activate the secondary motion to maintain substantially aggregation-free transport of the cells without sorting the cells along the cell transport path during the transport time period.

20. (Original) The apparatus of claim 19 wherein the means for imparting a primary motion of the cells comprises an electrode array having a first portion configured to apply a traveling wave dielectrophoretic field.

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21. (Currently Amended) The apparatus of claim 20 wherein the electrode array comprises has a second portion configured to apply at least one of: (1) the traveling wave dielectrophoretic field along with the first portion of the electrode array; and (2) a dielectrophoretic field configured for imparting the secondary motion,

wherein the second portion of the electrode array produces the secondary motion with the dielectrophoretic field via at least one of: (1) an electrorotative effect on the cells that rotates the cells; and (2) a centering effect on the cells that moves the cells toward a center of the transport path.

22. (Currently Amended) The apparatus of claim 24 An apparatus for moving cells on an electronic biodevice during a transport time period, the apparatus comprising:

means for imparting a primary motion of the cells on the biodevice to transport the cells between stations on the biodevice, and a secondary motion of the cells to substantially prevent aggregation of the cells during the cell transport, the means for imparting a primary motion of the cells comprising an electrode array having a first portion configured to apply a traveling wave dielectrophoretic field and the electrode array including a second portion configured to apply at least one of: (1) the traveling wave dielectrophoretic field along with the first portion of the electrode array; and (2) a dielectrophoretic field configured for imparting the secondary motion,

wherein the second portion of the electrode array is configured to produce the secondary motion with the dielectrophoretic field via at least one of: (1) an electrorotative effect on the cells that rotates the cells; and (2) a centering effect on the cells that moves the cells toward a center of the transport path,

wherein the means for imparting the secondary motion of the cells comprises a piezoelectric device disposed below the first portion of the electrode array, wherein the piezoelectric device and is configured to apply an ultrasonic force on the cells; and means for controlling the means for imparting, via control signals, to selectively activate the primary motion and the secondary motion to maintain substantially aggregation-free transport of the cells during the transport time period.

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23. (Currently Amended) The apparatus of claim 20 An apparatus for moving cells on an electronic biodevice during a transport time period, the apparatus comprising:

means for imparting a primary motion of the cells on the biodevice to transport the cells between stations on the biodevice, and a secondary motion of the cells to substantially prevent aggregation of the cells during the cell transport, the means for imparting a primary motion of the cells comprising an electrode array having a first portion configured to apply a traveling wave dielectrophoretic field; and

means for controlling the means for imparting, via control signals, to selectively activate the primary motion and the secondary motion to maintain substantially aggregation-free transport of the cells during the transport time period,

wherein the means for controlling the means for imparting comprises a transport control unit configured to apply the primary motion and the secondary motion in alternating cycles,

wherein the primary motion is produced by at least one of: (1) a fluid flow pressure drop; and (2) the first portion of the electrode array and comprises at least one of the traveling wave dielectrophoretic field applied via the first portion of the electrode array and a fluid flow pressure drop, and

wherein the secondary motion is produced via comprises at least one of a negative dielectrophoretic field and an ultrasonic force wave.

24. (Original) The apparatus of claim 23 wherein the transport control unit is configured to also apply the primary motion and the secondary motion simultaneously.

25-30. (Canceled)

31. (New) The biodevice of claim 1 wherein the array of operative stations comprises at least one of a cell testing station, a cell filter station, a cell sorting station, and a cell collecting station.

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32. (New) The apparatus of claim 19 wherein the operative stations of the biodevice comprise at least one of a cell testing station, a cell filter station, a cell sorting station, and a cell collecting station.